Penile transplants

For centuries, male genitalia have been a symbol of virility, and they continue to play a crucial role in a man’s overall wellbeing, sexuality and ability to procreate. While rare, severe penile defects resulting either from congenital malformations (such as bladder exstrophy-epispadias complex), malignant processes or trauma, represent perhaps the most emotionally and physically disturbing conditions. A conventional neophalloplasty, constructed from either a radial forearm free flap or a pedicled anterolateral thigh flap, has significant limitations. Despite some impressive refinements of the technique, this reconstructive approach is currently unable to completely restore lost penile anatomy and function.

In order to achieve a functional penis, patients with a neophallus require additional reconstructive surgery for placement of a penile prosthesis. Although a successful reconstructive technique for placement of an inflatable penile prosthesis has been established, it is still laden with the potential for catastrophic infection, erosion and even complete loss of the neophallus. Moreover, individuals with significant tissue loss secondary to combat-related trauma suffer significant injuries and amputations to their limbs, further limiting future potential for neophallus formation.

With these particular limitations in mind, and with well-established concepts of penile replantation and vascularised composite allografts for facial and limb transplantation, the concept of penile transplantation has now come to the forefront of genitourinary reconstruction.

Surgical successes

The first documented human penile transplantation was performed in 2006 at the Guangzhou General Hospital in China. The 44-year-old patient had lost his penis eight months earlier in a traumatic accident. Although the operation was reported to be successful, and with no clinical or histologic signs of rejection, the organ was removed at 14 days postoperatively due to ‘severe psychological problems of the recipient and his wife’. The second attempt, and first successful human penile transplantation, was performed in December 2014 at the Tygerberg Academic Hospital in Cape Town, South Africa. The patient was a 21-year-old man who three years
earlier had lost his penis due to a severe infection following a ritual circumcision. For this young man, a traditional ritual rite of passage into manhood had resulted in a catastrophic outcome.

Twenty-four months after the penile transplant the patient fully accepted his new penis and was reported to be ‘happy’ again, ascribing this to the complete restoration of all components of penile function. It was reported that he was urinating in a standing position, having spontaneous erections with normal orgasmic and ejaculatory experiences, and was able to impregnate his female partner and father a child. The same surgical team performed their second penile transplantation in April 2017 and are currently recruiting patients into a penile transplantation clinical trial.

The second successful penile transplantation was performed in May 2016 at the Massachusetts General Hospital in Boston. This successful transplantation was performed in a patient with a history of subtotal penectomy for penile cancer. At seven-month follow-up, the patient was reported to void spontaneously in a standing position and have partial recovery of penile sensation as well as spontaneous erectile function. Moreover, despite some challenges requiring additional surgical procedures for haematoma evacuation and eschar debridement, and medical adjustments to his immunosuppressive therapy, he was reported to have an improved self-image and overall health satisfaction.

Penis and scrotum
The next, and most recent, penile transplantation was performed in March 2018 at the Johns Hopkins Hospital in Baltimore, Maryland. During this surgery, both penis and the scrotum were transplanted as one large piece of tissue (Figure 1).

The recipient sustained a nearly complete penile and scrotal loss, in addition to severe lower extremity damage resulting in bilateral amputations, due to an improvised explosive device (IED) during his military service in Afghanistan. The powerful blast trauma is significantly different from the surgical penile amputation, or even penile tissue loss, due to infection. The force of the explosion, as well as multiple emergent life-saving surgery, followed by the debridement and reconstructive surgeries that ensued on his road to recovery, not only affected the penile and scrotal area but also the surrounding abdomino-pelvic skeletal and soft tissue structures.

The surgical team took a significant amount of time to plan for this patient’s surgery, accounting for all potential technical and patient-specific anatomic challenges. The 14-hour procedure repaired the patient’s abdominal wall, reconstructed his scrotal defect and attached a donor penis. Once the recipient’s penile stump was refreshed to the bleeding tissue, the penile structures were attached first, with the donor proximal urethra connected to the recipient’s urethral stump, expeditiously followed by the connection of the donor corpora cavernosa to the recipient’s. Next, the donor’s penile deep dorsal arteries were anastomosed to the recipient’s deep inferior epigastric arteries bilaterally, deep dorsal vein to the left deep inferior epigastric vein and the superficial dorsal vein to the right deep inferior epigastric vein. Lastly, the donor’s dorsal nerves were re-anastomosed to the recipient’s dorsal nerves. Once the phallus was re-perfused, the team re-anastomosed the vessels to the skin, with the donor’s superficial pudendal veins and arteries connected to the recipient’s greater saphenous veins and femoral arteries, respectively.

Due to controversial bioethical issues, the team chose not to transplant testicles. Two weeks after the surgery, the patient received bone marrow infusions from the donor. With this novel approach to manipulating the recipient’s immune responses and accepting donor tissue as self, the patient now requires a very low dose of oral immunosuppressive medication.

A unique niche
The geographic proximity of Johns Hopkins Hospital to the military centres in the area, as well as the well-established relationship with the United States military, created a very unique niche. It seems only natural that Johns Hopkins Hospital is focusing on treating wounded service personnel who have lost at least 75% of their genitals in combat and have limited reconstructive options due to their concomitant extremity injuries.

In fact, all members of the initial team that performed the hospital’s first bilateral arm transplant for a combat veteran who lost all four of his limbs in a roadside bomb attack while serving in Iraq, participated in this recent endeavour. The team, composed of nine plastic surgeons and two urological surgeons as well as fellows and trainees, dedicated countless hours into making this penile transplantation a successful surgery. They are not the only ones deserving acknowledgement, however, as the truly multidisciplinary team encompassing surgical, medical and mental health professionals as well as countless nursing and support staff assisted.
along the way. Lastly, and perhaps more importantly, the donor’s family must be recognised for their willingness to donate, as without the donated organ none of the preparatory efforts could come to fruition.

**Conclusion**

Despite the current technical, ethical and organ shortage challenges, the recent successful penile transplantation surgeries present a revolutionary option for penile disfigurement. As the nuances of organ donation, transplantation and immunologic tolerance are rapidly advancing, penis and scrotal transplantation may soon be able to be offered to a much broader patient population. Furthermore, with the evolution and perfection of this scientific advancement, penile transplant may be even offered as an additional option for treatment of severe erectile dysfunction. Although this idea may seem to be very provocative now, who thought a decade ago that penile transplantation was possible at all?

**Declarations of interests:** none declared.

**References**